



Research article

The influence of COVID-19 on intertemporal choices in the health and economy domains

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ABSTRACT

Background: With the spread of COVID-19, concerns regarding its adverse effects have arisen. Based on affect regulation theory and construal level theory, this study explored how COVID-19 affects intertemporal choice in the health and economy domains, self-other differences for intertemporal choice were also inspected. The study examined whether psychological safety can moderate the relationship between COVID-19 and intertemporal choice.

Methods: A 2 (COVID-19 status: pre-COVID-19, during-COVID-19) × 2 (decision maker role: decision for self, decision for others) × 2 (domain: health, economy) three-factor hybrid experiment was employed.

Results: (1) Individuals in during-COVID-19 condition preferred more immediate options. (2) Delayed options were preferred more in the health domain. Preference for immediate money options enhanced during than before COVID-19. However, COVID-19 status did not affect choices related to health. (3) Delayed options were preferred more when making intertemporal choices for others than for oneself under the pre-COVID-19 condition. Self-other differences for intertemporal choice disappeared during COVID-19. (4) Psychological safety moderated the effect of COVID-19 on intertemporal choice.

Conclusions: During COVID-19, individuals' impulsive preference of intertemporal choice increased. COVID-19 affected intertemporal choice regarding economy and the self-other differences for intertemporal choice. Psychological safety could buffer the effect of COVID-19 on intertemporal choice.

Value: This study can provide empirical evidence to affect regulation theory and level of explanation theory as well as guide individuals in making scientific decisions in health and economic domains under public health emergencies.

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1. Introduction

Intertemporal choice refers to the process wherein individuals consider the costs and benefits of options occurring at different periods before making a decision [1,2]. Choosing between immediate and delayed options is the common paradigm of intertemporal choice (e.g. ‘Would you prefer [A] 30 CNY today OR [B] 50 CNY in 10 days?’) (According to the exchange rate of RMB and US dollar, 1 CNY \approx 0.14 USD).

Motivated by the inspiring arguments that COVID-19 may seriously increase the delay discounting (the tendency of individuals assign less value to future rewards compared with immediate ones, [3,4] due to the increased uncertainty of future events [5], it is urgent to verify whether COVID-19 affects individuals’ intertemporal choices through empirical research. How do individuals make intertemporal choices for themselves and others during COVID-19? Existing research recognizes the domain specificity for intertemporal choice, while very little is currently known about the impacts of COVID-19 on intertemporal choice in the health and economy domains which have suffered a great storm and how to alleviate the negative effects of COVID-19 on intertemporal choice.

1.1. COVID-19 and intertemporal choice

Previous studies have suggested that disaster events would lead to an increase in the discount rate of intertemporal choice, and individuals may show a stronger preference for immediate options [6–9]. Cassar et al. (2017) proposed that disaster makes people more aware of possible adverse events and even shorten their life expectancy; this may cause impatience or risk aversion [7]. COVID-19 has deteriorated into a global health safety disaster, which may have a strong impact on individuals’ intertemporal choice besides human health and global economy.

In the pandemic of COVID-19, the strong infectivity of the virus and the continuous deterioration of domestic situations prompted increasingly prominent negative responses, such as depression and anxiety [10,11]. Extensive research has found that negative emotions cause individuals to be more short-sighted and prefer immediate gains [12,13]. Based on the affect regulation theory, people have a strong motivation to pursue happiness, and they may take effective measures to dispense with negative emotions. Therefore, individuals affected by negative emotions may have a stronger preference for immediate options and implement immediate satisfaction behaviour [14,15]. To conclude, we assume that individuals will prefer more immediate options during than before COVID-19. We propose the following hypothesis accordingly.

H1. The main effect of COVID-19 status is significant. Compared with the pre-COVID-19 condition, the preference for immediate options is enhanced under the during-COVID-19 condition.

1.2. COVID-19 and self-other intertemporal choice

Available researches have focused on how humans make intertemporal decisions for themselves, such as whether to save or immediately consume wages [16]. Making intertemporal choices for others is similarly common in daily life. For example, fitness coaches make daily diet plans and fitness programs for clients, and individuals may formulate savings plans for colleagues [17]. ‘Self-other intertemporal choice’ focuses on the difference between individuals make intertemporal choice for themselves and others and is currently being extensively studied [18,19].

Several attempts have been made to explore self-other differences in intertemporal choice; consensus on the conclusions has not been reached, unfortunately. Most studies have found that individuals who make intertemporal choices for others are more likely to choose delayed options than for themselves [17,19–21]. However, others suggested that individuals who make intertemporal choices for others rather than themselves preferred more immediate options [16]. Several studies have found that changes in construal levels are attributed to psychological distance [22], and that these levels significantly influence cognitive processes such as decision-making and judgment in individuals [23,24]. The construal level theory pointed out that for objects with long and short psychological distances, people tend to apply high and low construal levels, respectively, to represent and pay attention to certain attributes [21,25,26]. Individuals tend to adopt high construal levels and pay more attention to the attributes of high construal levels (e.g. amount) when making intertemporal choices for others due to the long psychological distance, which explains the preference for delayed options. However, when making intertemporal choices for themselves, individuals tend to apply low construal levels and pay more attention to the attributes of low construal levels (e.g. time); hence, immediately available options are preferred [22,25,27]. Therefore, we propose the following hypothesis.

H2. The main effect of the decision maker role is significant. When making intertemporal choices for others than themselves, decision makers prefer delayed options.

At present, research on self-other intertemporal choice involves daily situations. However, the characteristics of self-other intertemporal choice during emergencies remain elusive. Making intertemporal choices for others is common during the current outbreak; this includes numerous medical experts making treatment decisions and health suggestions for patients [28]. Given the strong impact of COVID-19 on physical and mental health, as well as interpersonal relationships, self-other intertemporal choices during the epidemic might differ from those before the epidemic. Recently, a few studies have pointed out that making intertemporal choices for others involves the interpersonal process [29], so interpersonal relationship between individuals and others may affect the intertemporal choices made for oneself and others. Strict control on physical distance and quarantine have been enforced nationally to prevent the spread of the virus [30,31] While reducing the risk of virus transmission, these measures also negatively impacted interpersonal relationships, as embodied by the increased physical distance between individuals and decreased social frequency [32].

The outbreak of COVID-19 is likely to increase psychological distance, resulting in self-other differences for intertemporal choice alien from those before the epidemic.

The risk-as-feelings hypothesis in the field of risky choice proposes that individuals are more emotionally involved when they make decisions for themselves than others, and the decisions made for others may only be partially based on their own emotions [33]. Risky choice and intertemporal choice are similar in theory, both including discounting and non-discounting models [2,34]. Additionally, similar behavioral effects have been observed in the two fields (e.g. the certainty and immediacy effects in risky and intertemporal choices, respectively, both reflect individuals' preference for certainty). Regarding intertemporal choice, similar differences in emotional involvement may occur when making intertemporal decisions for oneself and others. Compared with making intertemporal choices for oneself, making intertemporal choices for others will be less affected by individuals' emotions. The domestic safety situation is becoming increasingly severe due to the rampancy of COVID-19. As a negative stressor, COVID-19 has elicited various degrees of depression, anxiety, fear, and other negative emotions [10], negative emotions may affect intertemporal choices made for oneself than for others, further. Thus the emergence of COVID-19 may alter self-other intertemporal choices. We propose the following hypothesis accordingly.

H3. The interaction between COVID-19 status and decision makers role is significant. In the during-COVID-19, the difference of self-other intertemporal choice is greater than that in the pre-COVID-19 condition.

1.3. COVID-19 and the domain specificity of self-other intertemporal choice

Current research has tended to focus on the domain specificity of self-other risky choice and has found that, in the domain of heterosexual dating, making choices for others than oneself is more risk-taking. Regarding personal safety, one is more risk-averse when making choices for others than oneself [35–37]. Regarding social value theory, when making decisions associated with risk for others, values respected by society will be largely considered by decision makers. Individuals make decisions for others according to social norms recognized by most people. The values or norms that are respected by different domains may differ. For example, risk seeking in the domain of heterogeneous dating is of social value. Conversely, in the personal safety domain, risk aversion possesses social value. Therefore, domain specificity has become known in self-other risky choice [38,39].

Moreover, the epidemic has strikingly affected economic development besides personal safety [40], as economic order has come to a temporary standstill and consumer spending has been more disordered. Several studies have found that a significant relationship between individuals' perceived risk of COVID-19 and hoarding behaviors [41]. For instance, in certain countries or regions, there has been an observed tendency among people to stockpile medical supplies, toilet paper, and even items devoid of value [42]. Moreover, recent studies have indicated a higher prevalence of sub-health status in the population compared to pre-outbreak levels [43]. This study focuses on the health and economy domains significantly affected by COVID-19. Options related to health or money are sharply distinct in utility, value, and tradability [44]. Previous research comparing the time discount rate of health outcomes and monetary gains has found that people discount monetary gains more steeply than health outcomes [45,46]. Accordingly, we propose the following hypothesis.

H4. The main effect of the domain is significant. Compared to the intertemporal choice in the economy domain, individuals prefer delayed options in the health domain.

The effects of COVID-19 on intertemporal choice in the health and economy domains are also likely to be discrepant due to the differences of attributes of healthy and monetary rewards. Given that individuals have different preferences for intertemporal choice in the health and economy domains, the self-other intertemporal choice may be domain-specific. Therefore, we propose the following hypotheses.

H5. The interaction of COVID-19 status and domain is significant.

H6. The interaction of decision maker role and domain is significant.

The effect of COVID-19 on intertemporal choice in the health and economy domains will likely differ. We further speculate that the effect of COVID-19 on self-other intertemporal choice in the economy and health domains may be inconsistent, thus we propose the following hypothesis.

H7. The interaction among COVID-19 status, decision maker role, and domain is significant.

1.4. Effect of COVID-19 on intertemporal choice: the moderating role of psychological safety

Individuals with various levels of psychological safety may act out diversely adaptive behaviors during disastrous events or other threatening situations [47]. Positive psychological resources can balance or even offset the negative effects of adverse situations [48, 49]. Psychological safety refers to an individual's premonition of crisis events or risks that may endanger their psychological or physical homeostasis. It is also associated with coping, which is mainly characterized by a sense of certainty and perceived control [47, 50]. Psychological safety reflects people's perceptions about threats to their survival and safety [51]. Existing research revealed that individuals with high psychological safety after an earthquake perceived less uncertainty and possessed a relative higher sense of control, thus they can actively seek the meaning of traumatic events and adapt better. Conversely, individuals with low psychological safety may lose the basic sense of certainty and control of life after experiencing traumatic events, exhibiting negative cognition and maladaptive behaviors [47,52].

Considering compensation strategies for psychological safety, people who lack psychological safety have the motivation to improve or compensate for psychological safety. For example, making use of the positive experience of money or other aspects to compensate for the negative experience caused by lack of psychological safety [53,54]. One possible phenomenon is excessive consumption after psychological safety gets threatened [55]. For intertemporal choice, the primary feature of the immediate option is that it can be obtained as soon as it is selected, while the delayed option is uncertain due to the passage of time. Conversely, determined immediate options may compensate for individuals with low psychological safety immediately. During COVID-19, threats from the surrounding environment have a greater impact on individuals with low psychological safety, which may cause them to prefer immediate options in intertemporal choice. Individuals with high psychological safety may be less affected by COVID-19. That is, psychological safety may buffer the effect of COVID-19 on intertemporal choice. Accordingly, we propose the following hypothesis.

H8. Psychological safety plays a moderating role on the relationship between COVID-19 and intertemporal choice.

1.5. Aims of the present study

This study addresses literature gap by examining, for the first time, the impact of COVID-19 on intertemporal choice for oneself or others within both economic and health domains, while also testing its boundary conditions. Specifically, we explored the impacts of COVID-19 on intertemporal choice in the health and economy domains and further examined the effects of COVID-19 on self-other intertemporal choice in the above domains. Finally, we tested whether the relationship between COVID-19 and intertemporal choice was moderated by psychological safety. The conclusion of the study is anticipated to yield empirical evidence that will impact affect regulation theory and construal level theory, as well as offer valuable guidance for self-other decision-making in similar crisis situations like the COVID-19. (The overview of the study hypotheses were shown in Table 1).

2. Method

2.1. Participants

A sample size of $N = 72$ was required for this experiment based on the effect size reported in the relevant research and the expected power (0.95); 230 students from $\times \times$ University were selected in the current study. The participants who did not complete the experiment and did not respond carefully were excluded. The final sample was 207 (73 men and 134 women), aged 20.6 ± 1.3 years and with monthly living expenses of 1453.8 CNY on average. Written informed consent was obtained from all participants. The procedure was approved following the ethics standards of the Academic Board of Kashi University [approval number:KSU2005] and the declaration of Helsinki in 1964.

2.2. Design

This study employed a 2 (COVID-19 status: pre-COVID-19, during-COVID-19) $\times 2$ (decision maker role: decision for self, decision for others) $\times 2$ (domain: health, economy) mixed design. COVID-19 status was the between-subject variable, and decision maker role and domain were the within-subject variables. To compare with the early studies [20], we used the proportion of choosing immediate options in intertemporal choice as the dependent variable.

2.3. Tasks and experimental materials

Intertemporal choice task in the health domain. This study compiled intertemporal choice tasks based on BMI [BMI = weight (kg)/height² (m)]. Cronbach's α was 0.751. Participants were required to choose whether to lose weight immediately to reach a lower level

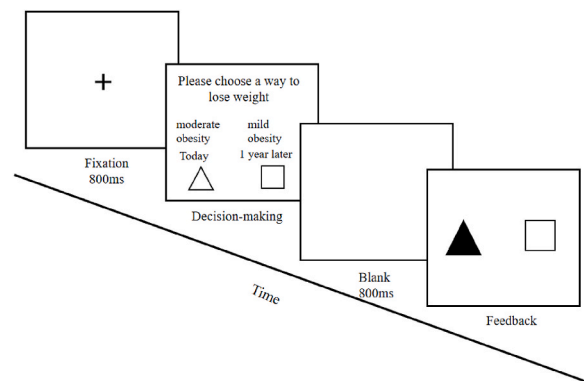


Fig. 1. Experimental procedure in the health domain.

of obesity or adhere to healthy habits for a year to reach a healthier level, for themselves and others, respectively. For example, ‘If you were severely obese and wanted to lose weight, please choose between the two options after careful comparison. Option 1: Lose weight immediately; your weight recovers to ‘moderate obesity’ and is easy to regain. Option 2: Control your diet and engage in physical activity. After a year of persistence, recover to ‘mild obesity’, with the weight not being easy to regain’. Option 1 represents a smaller weight loss effect in the short term, while Option 2 represents an individual’s ability to achieve a better weight loss effect, albeit requiring a longer duration of effort. This provides a valuable measurement of the trade-off between “immediate smaller health-related rewards” and “delayed larger health-related rewards.” The experimental procedure were shown in Fig. 1.

Intertemporal choice task in the economy domain. Based on investigations on the socio-economic status of college students, this study revised the intertemporal choice task developed by McClure et al. (2004). Participants chose between sooner-smaller options and later-larger options for themselves and others [56]. Combined with COVID-19, the present study set the delay time to one year. And the delay time is consistent with intertemporal choice task in the health domain. The immediate rewards were randomly selected from the normal distribution, which were 200 CNY, 300 CNY, 400 CNY, 600 CNY, 800 CNY, 900 CNY, 1000 CNY, and 1200 CNY. The delay rewards were 1200 CNY and 1500 CNY. The experimental procedure were shown in Fig. 2.

Psychological safety. This was measured using the safety questionnaire developed by Cong and An (2004). The 16-item scale includes two factors: interpersonal safety and certainty in control [50]. For example, ‘I’m afraid to build and maintain close relationships with others’ and ‘I feel that life is always full of uncertainty and unpredictability’. The items provide a better measurement of psychological safety characteristics during COVID-19. The items were scored on a 5-point Likert scale (1 = agree completely, 3 = neutral, and 5 = disagree completely). Higher scores indicated higher psychological safety. The all items of the questionnaire were shown in Table 2. Cronbach’s α was 0.865.

2.4. Procedure

Data were collected online during the COVID-19 was spreading in China. The retrospective method was used in pre-COVID-19 condition (Because by this time, the COVID-19 was already spreading in China). Participants were randomly divided into two groups, pre-COVID-19 and during-COVID-19 conditions, with 115 participants in each group. The researchers first introduced the purpose of the experiment, and then participants signed the informed consent. Given that some participants failed to pass the attention check, 96 and 111 participants were finally included in the pre-COVID-19 and during-COVID-19 conditions, respectively.

Participants first read a section of text related to COVID-19. Then, they completed intertemporal choice tasks in the economy and health domains and for oneself and others, respectively. Finally, they completed the questionnaire regarding psychological safety and demographic questions.

The retrospective method was used in the pre-COVID-19 condition. Participants read the following, ‘Imagine that you return to the days prior to COVID-19, and you are free to go out, go to parties, and even travel. There is no quarantine and requirements regarding mask-wearing. You don’t have to be frightened of fever and other symptoms’. Sufficient imagination is necessary. Then, participants recalled how they would make choices before the epidemic.

Participants in the during-COVID-19 condition read about the current situation of COVID-19, namely, ‘At the beginning of 2020, COVID-19 was suddenly rampant. The number of diagnosed cases is rising now. Masks, quarantine, virus, incubation periods, new cases, and diagnosed cases permeated daily life. It would be better to stay at home, reduce going out, and even quarantine. The outbreak of COVID-19 in more countries made the situation grimmer. At present, we remain in a severe situation, and it is still unknown when the epidemic will end.’ Participants then completed the intertemporal choice tasks based on the current situation of COVID-19 and their feelings at the moment. The study design and experimental procedure were shown in Fig. 3.

2.5. Statistical analysis

All the analyses were performed using SPSS 21.0. We first conducted a descriptive statistical analysis of individuals’ preference for

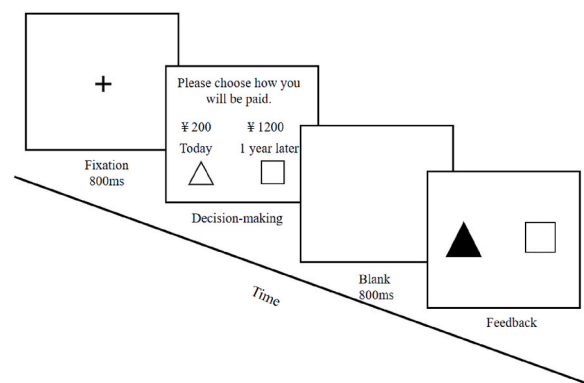


Fig. 2. Experimental procedure in the economy domain.

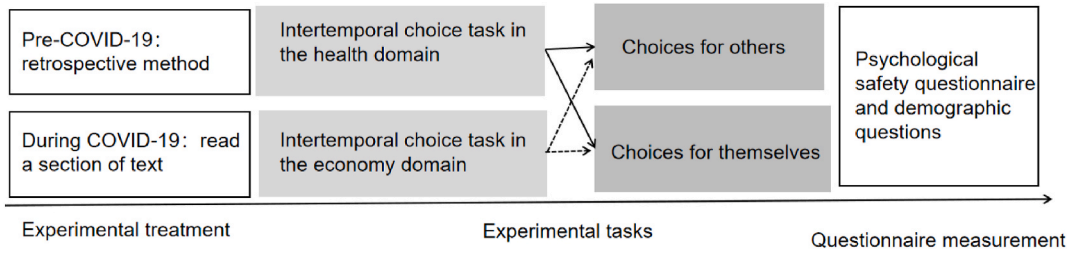


Fig. 3. Study design and experimental procedure.

intertemporal choice. Mixed-design ANOVA was performed in the main analyses. Second, we ran a moderating analysis using hierarchical regression and PROCESS macro for SPSS21.0 [57]. 95 % confidence intervals (CI) were estimated using 5000 iterations of bootstrapping to measure all the effects.

3. Results

3.1. Proportion of choosing immediate options in intertemporal choice

In this study, mixed-design ANOVA of 2 (COVID-19 status: pre-COVID-19, during-COVID-19; between) × 2 (decision maker role: decision for self, decision for others; within) × 2 (domain: health, economy; within) was conducted. The descriptive statistical results were shown in Table 3.

The results showed that the main effect of COVID-19 status was significant, $F(1, 205) = 6.899, p = 0.009, \eta_p^2 = 0.033$ (The significance level of $p < 0.05$ in ANOVA indicates statistically significant results, while a significance level of $p < 0.001$ suggests highly significant findings. It is important to note that significant results imply the presence of meaningful differences). Compared with pre-COVID-19 ($M = 0.196, SD = 0.158$) (“M” represents the statistical measure of mean, while “SD” denotes the measurement of standard deviation.), participants were more inclined to choose immediate options in the during-COVID-19 condition ($M = 0.260, SD = 0.189$). The main effect of the decision maker role was significant, $F(1, 205) = 6.268, p = 0.013, \eta_p^2 = 0.030$. When making intertemporal choices for oneself ($M = 0.252, SD = 0.317$) versus for others ($M = 0.209, SD = 0.289$), the participants preferred immediate options. The main effect of domain was significant, $F(1, 205) = 14.031, p < 0.001, \eta_p^2 = 0.064$. The participants in the economy domain ($M = 0.271, SD = 0.278$) versus in the health domain ($M = 0.190, SD = 0.323$) preferred immediate options.

The 3-way interaction among COVID-19 status, decision maker role and domain was not significant, $F(1, 205) = 1.458, p = 0.229, \eta_p^2 = 0.007$. So we focus on 2-way interactions. The interaction between COVID-19 status and decision maker role was significant, $F(1, 205) = 5.350, p = 0.022, \eta_p^2 = 0.025$. Further simple effect test showed that when participants made intertemporal choices for others, the proportion of immediate options ($M = 0.258, SD = 0.019$) was significantly higher under during-COVID-19 condition than that under pre-COVID-19 condition ($M = 0.152, SD = 0.021$), $F(1, 205) = 13.965, p < 0.001, \eta_p^2 = 0.064$. When participants made intertemporal choices for themselves, there was no significant difference in the proportion of immediate options between the pre-COVID-19 ($M = 0.240, SD = 0.024$) and during-COVID-19 conditions ($M = 0.262, SD = 0.022$), $F(1, 205) = 0.443, p = 0.506, \eta_p^2 = 0.002$. In addition, there was decision maker role effect in the pre-COVID-19 condition. Specifically, making intertemporal choices for others preferred more delayed options than for oneself, $F(1, 205) = 10.816, p = 0.001, \eta_p^2 = 0.050$. Under the during-COVID-19 condition, there was no significant difference between the intertemporal choices for self and for others, $F(1, 205) = 0.020, p = 0.889, \eta_p^2 = 0.000$ (See Fig. 4).

The interaction between COVID-19 status and domain was significant, $F(1, 205) = 5.862, p = 0.016, \eta_p^2 = 0.028$. Further simple effect test showed that when participants made intertemporal choices in the economy domain, the proportion of choosing immediate

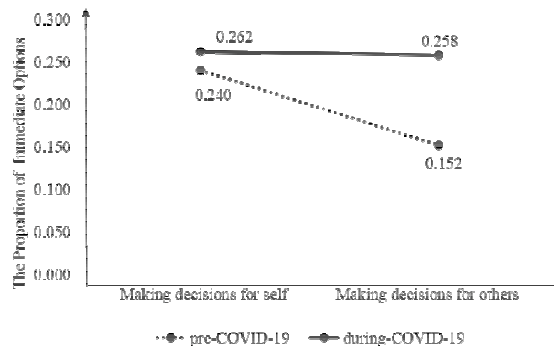


Fig. 4. The interaction between COVID-19 status and decision maker role.

options under the during-*COVID-19* condition ($M = 0.323$, $SD = 0.019$) was significantly higher than under the pre-*COVID-19* condition ($M = 0.209$, $SD = 0.021$), $F(1, 205) = 15.850$, $p < 0.001$, $\eta_p^2 = 0.072$. When participants made intertemporal choices in health domain, there was no significant difference in the proportion of immediate options between the pre-*COVID-19* ($M = 0.182$, $SD = 0.026$) and during-*COVID-19* conditions ($M = 0.197$, $SD = 0.024$), $F(1, 205) = 0.170$, $p = 0.680$, $\eta_p^2 = 0.001$. In addition, there was no significant difference in the proportion of immediate options in the economy and health domains under the pre-*COVID-19* condition, $F(1, 205) = 0.818$, $p = 0.367$, $\eta_p^2 = 0.004$. While under the during-*COVID-19* condition, the proportion of immediate options in the economy domain was significantly higher than in the health domain, $F(1, 205) = 20.501$, $p < 0.001$, $\eta_p^2 = 0.091$ (see Fig. 5). The interaction between decision maker role and domain was not significant, $F(1, 205) = 2.770$, $p = 0.098$, $\eta_p^2 = 0.013$.

3.2. The moderating effect of psychological safety

Hierarchical regression analysis was used to investigate the moderating effect of psychological safety on the relationship between *COVID-19* and intertemporal choice. Results are shown in Table 4. The *COVID-19* status was recoded (pre-*COVID-19* = 0, during-*COVID-19* = 1), and the dependent variable was the proportion of choosing immediate options in intertemporal choice. The results showed that psychological safety played a moderating role in the effect of *COVID-19* status on intertemporal choice ($\beta = -0.252$, $t = -3.768$, $p < 0.001$).

To further analyse the moderating effect, We used Model 1 in PROCESS and divided participants into two groups according to the z-score of psychological safety: 1 (high psychological safety) and -1 (low psychological safety). The results are shown in Fig. 6. *COVID-19* status affected the proportion of choosing immediate options in intertemporal choice and was moderated by psychological safety. For those with low levels of psychological safety, the positive predictive effect of *COVID-19* status on the proportion of choosing immediate options was significant. (effect size = 0.091, $SE = 0.018$, $p < 0.001$, 95 % CI [0.056, 0.127]); meanwhile, for those with high levels of psychological safety, the effect of *COVID-19* status on the proportion of immediate options was not significant, (effect size = -0.003, $SE = 0.017$, $p = 0.86$, 95 % CI [-0.036, 0.030]).

4. Discussion

The present study found that the main effect of *COVID-19* status was significant, which was in line with hypothesis H1. Compared with the pre-*COVID-19* condition, individuals' preference for immediate options enhanced under the during-*COVID-19* condition. This indicated that individuals were more short-sighted and that impulsive choice behaviour increased during *COVID-19*, which follows earlier observations that disasters incurred the decline of intertemporal choice patience [6–9]. *COVID-19* partly impaired the rationality of intertemporal choice in addition to the detrimental effects on health. These results are consistent with the affect regulation theory. During *COVID-19*, people have negative emotional distress [10,11]. Individuals pursue instant gratification to obtain better feelings and relieve the disturbance caused by negative emotions [14,15]. Therefore, during the *COVID-19* epidemic, people preferred immediate options when making intertemporal choices. Li et al. (2012) explored the difference of intertemporal choice between the earthquake survivors and the control group in non-earthquake-stricken areas [8]. Survivors were more inclined to choose immediate gains and the N300 amplitude reflecting inhibition control decreased when they made intertemporal choices involving immediate gains. Based on the dual-process model of choice, we speculate that during *COVID-19* the intertemporal choice process of individuals may involve more negative emotions such as depression, anxiety, and fear and less rationality; as such, the degree of rationality of intertemporal choice decreased and impulsive preference increased. As we enter the post-epidemic era, with the waning of anxiety and fear induced by the epidemic, it is anticipated that individuals' impulsivity will revert to pre-epidemic levels.

The results showed that the main effect of the decision maker role was significant, which was consistent with hypothesis H2 and the literature available. Specifically, the preference for delayed options was greater when making intertemporal choices for others than for oneself [17,19–21]. This is contrary results of Wang, Hao et al. (2019) who found that when making intertemporal choices for a

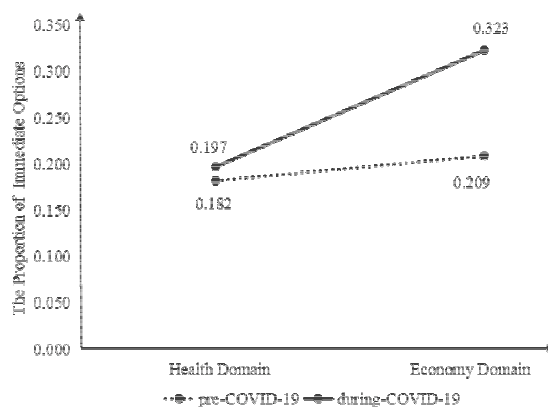


Fig. 5. The interaction between *COVID-19* status and domain.

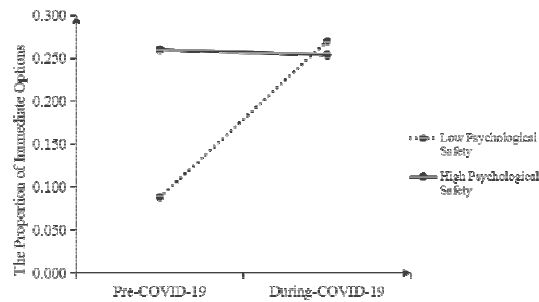


Fig. 6. Psychological safety moderates the effect of COVID-19 on intertemporal choice.

stranger rather than for oneself, individuals are more likely to favour immediate options [18]. A possible explanation might be that Wang et al. (2019) selected participants who focused on chronic prevention and promotion [16]. Following the construal level theory, when individuals make intertemporal decisions for others, attributes associated with high construal level (e.g. amount) will be paid more attention [22,25,27]. However, time, as an attribute related to low construal level, is ignored to some extent. Delayed options are thus preferred when making intertemporal choices for others. Xu and Xie (2011) explained self-other differences for intertemporal choice from the perspective of the desirability and feasibility of options [26]. They provided a new perspective, wherein individuals focused on the feasibility of options when making intertemporal choices for themselves and paid more attention to the desirability of options when representing others. The delayed options with lower feasibility but higher desirability compared to immediate options are preferred when making intertemporal choices for others.

The results indicated that COVID-19 status and decision maker role interacted significantly. Under the pre-COVID-19 condition, the differences between making intertemporal choices for oneself and others were significant. Individuals preferred delayed options for others than themselves. It is of note that no significant difference emerged when making intertemporal choices for oneself and others under the during-COVID-19 condition. Individuals preferred immediate options both for themselves and for others. The results were inconsistent with hypothesis H3. Although the physical distance between individuals increased and the social frequency decreased during the epidemic [32], the self-other differences for intertemporal choice disappeared. Previous research has found that when decision makers are engaged in making decisions for intimate people, social distance is relatively close and self-other differences may not be observed. However, self-other differences emerged when making decisions for strangers who are socially distant [16,19,58]. Given that the core difference between self and others is the social distance [58], it is likely that the epidemic has greatly shortened the social distance between individuals, resulting in no significant difference in self-other intertemporal choice.

Why does the social distance between individuals and others decrease during COVID-19? Previous studies have found that the common experience of disaster contributes to enhanced social connection, thus promoting intimate relationships [59,60]. Catastrophic events also predicted an increase in individuals' prosocial behaviours [7,61], such as property donation, blood donation, and voluntary service. Furthermore, these events may enhance trust [7] and empathy [62]. Empathy makes people accurately understand the feelings of others [63], which is conducive to narrowing the social distance between individuals. Therefore, we speculate that special and close emotional connections with others (even strangers) may be established during COVID-19, thereby narrowing the social distance and leading to the disappearance of self-other differences for intertemporal choice.

The results revealed that the main effect of the domain was significant. People are more inclined to choose delayed options in the health domain than in the economy domain. There was domain specificity in intertemporal choice, which was consistent with hypothesis H4. Delayed health outcomes are more valuable to individuals than delayed money gains [45,46]. Previous studies on intertemporal choice in the health domain mostly adopted situations associated with disease and backache; these required imagination and were easily affected by personal experience [44]. The weight loss situation is closely related to real life, which is conducive to the accurate measurement of intertemporal choice in the health domain. The intertemporal choice paradigm in the health domain of this study also reflects the cost of health outcomes and the necessity of duration. Therefore, higher ecological validity of weight loss situation may provide measurement support for future research on intertemporal choices in the health domain.

A significant interaction between COVID-19 status and domain was shown in the current study, which was consistent with hypothesis H5. When making intertemporal choices in the economy domain, participants under the during-COVID-19 condition were more inclined to choose immediate options than those under the pre-COVID-19 condition. However, when making intertemporal choices in the health domain, there was no significant difference between pre-COVID-19 and during-COVID-19 conditions. Under the during-COVID-19 condition, the proportion of participants choosing the immediate options slightly higher than that under the pre-COVID-19 condition. The results may be explained by the fact that the epidemic has brought economic trauma and that private property has suffered varying degrees of losses [64]. Immediate access to money can compensate for the loss. Simultaneously, people who experienced disasters may reckon that the future is unpredictable and that money paid in one year is of great uncertainty [65]. Accordingly, people discount deferred options more and prefer immediate options in the economy domain. Individuals showed a significant decrease in patience in the during-COVID-19 condition compared with those in the pre-COVID-19 condition. However,

when individuals made intertemporal choices in the health domain under the during-COVID-19 condition, the background of the epidemic may trigger their awareness of death and the limitations of life span. Their adaptive time management strategies are stimulated, and future orientation is strengthened [16]. This enables people to focus on long-term health goals and enhance preferences for future health outcomes. Therefore, for intertemporal choices in the health domain, individuals under the during-COVID-19 condition only showed a slightly stronger preference for immediate options compared with those under the condition of pre-COVID-19 and no significant decrease in patience emerged.

The effect of COVID-19 on intertemporal choice was moderated by psychological safety, which was consistent with hypothesis H8. The prevalence of COVID-19 causes individuals to be more impulsive when making intertemporal choices and to prefer immediate options; this negatively impacts the future development of individuals and the stability of social order [66]. We found that psychological safety aided in alleviating the effect of COVID-19 on intertemporal choice. The higher the psychological safety, the smaller the effect of COVID-19 on intertemporal choice. Positive psychological resources can balance or even offset the negative effects of adverse situations [48,49]. Psychological safety as a positive psychological resource is conducive to coping with stress and threats [47]. Studies have found that perceived control can improve individuals' coping skills [67] and that it is a protective factor to prevent the serious psychological effects of COVID-19 [68,69]. Psychological safety also involves the dimension of certainty in control and can moderate the relationship between COVID-19 and intertemporal choice. Therefore, the factors related to perceived control may be the key protective factors in the adverse situations of COVID-19.

5. Conclusion

This study found that individuals preferred more immediate options during than before COVID-19. COVID-19 significantly affected the self-other intertemporal choice. In the pre-COVID-19 condition, those who made intertemporal choices for others than themselves preferred delayed options. However, in the during-COVID-19 condition, there was no significant difference between the choices for oneself and others. For intertemporal choices in the economy domain, individuals in the during-COVID-19 condition preferred more immediate options than those in the pre-COVID-19 condition, while COVID-19 status did not affect intertemporal choice in the health domain. Finally, psychological safety can buffer the effect of COVID-19 on intertemporal choice. The findings of the current study will provide valuable insights for effectively managing similar crisis scenarios in the future and reducing impulsive behaviour among individuals in the economic sphere.

6. Implications

First, this study can help researchers and the public understand that COVID-19 impairs not only physical and mental health but also damages individuals' intertemporal choice. People prefer immediate options during COVID-19. Second, self-other intertemporal choice can be affected by COVID-19, which lays a foundation for future research on the impact of background factors such as emergencies on self-other intertemporal choice. Third, the effects of COVID-19 on intertemporal choice in health and economy domains are inconsistent, which indicates that domain specificity should be considered to accurately reveal the relationship between emergencies and intertemporal choice. Finally, this study found that psychological safety can buffer the effect of COVID-19 on intertemporal choice. Promoting psychological safety is expected to be an effective way to improve individuals' intertemporal choice during the prevalence of COVID-19.

7. Limitations and future directions

This study has the following limitations. First, this study only explored the effect of COVID-19 status on intertemporal choice. However, future studies may benefit from exploring the mechanism of differences for intertemporal choice between pre-COVID-19 condition and during-COVID-19 condition. For example, eye movement technology may be done to explore information-processing mechanisms. Electroencephalogram and neuroimaging technology (e.g. functional magnetic resonance imaging) can be used to obtain evidence of event-related potentials and cortex activation of intertemporal choice in different epidemic stages.

Second, our participants were all college students. People affected by COVID-19 come from different backgrounds. This limitation may affect the generalizability of results. Future research must involve a wider range of occupational groups, expand the age range of participants, carry out empirical research on special groups (such as patients with depression).

Third, retrospective self-report data collected in pre-COVID-19 condition is also a limitation, which may be potentially influenced by other factors. Data acquired in the absence of the COVID-19 were better at revealing the findings.

Fourthly, intertemporal choice in this study only involved gain situations, and loss situations (i.e. the trade-off between present and future losses) were not included. Additionally, whether COVID-19 affects anomalies in intertemporal choice (e.g. magnitude effect and time frame effect) can be further investigated through experiments.

Finally, the current study only examined the influence on intertemporal decision-making in the economic and health domains before and during COVID-19, without considering the post-COVID-19 scenario. To comprehensively investigate the impact of COVID-19 on intertemporal decision making, future research could incorporate pre-, during-, and post-COVID-19 conditions simultaneously.

Data availability statement

The data for "The Influence of COVID-19 on Intertemporal Choices in the Health and Economy Domains" [DS/OL]. V1. Science

Data Bank, 2024 [2024-05-14]. <https://cstr.cn/31253.11.sciencedb.07920>. CSTR:31253.11.sciencedb.07920.

CRedit authorship contribution statement

Dawei Wang: Writing – review & editing, Writing – original draft, Supervision, Project administration, Investigation, Conceptualization. **Xinxiao Nie:** Writing – original draft, Methodology, Formal analysis, Data curation. **Yaxi Zhou:** Writing – review & editing, Methodology, Investigation, Formal analysis, Data curation. **Jiade Ye:** Writing – review & editing, Resources, Investigation, Data curation, Conceptualization. **Peng Yu:** Writing – review & editing, Supervision, Methodology. **Yixin Hu:** Writing – review & editing, Writing – original draft, Project administration, Conceptualization. **Xiaodong Jin:** Writing – review & editing, Project administration, Methodology, Data curation.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix

Table 1
Overview of the study hypotheses and hypothesis testing situation

Hypothesis	Independent variable A : COVID-19 status		Independent variable B: domain		Independent variable C: decision maker role		Testing situation
	pre-COVID-19	during COVID-19	economy	health	choices for others	choices for themselves	
H1	The main effect of COVID-19 status is significant. Compared with the pre-COVID-19 condition, the preference for immediate options is enhanced under the during-COVID-19 condition (main effect of A).						Hypotheses 1 is supported.
H2	The main effect of the decision maker role is significant. When making intertemporal choices for others than themselves, decision makers prefer delayed options (main effect of C).						Hypotheses 2 is supported.
H3	The interaction between COVID-19 status and decision makers role is significant. In the during-COVID-19, the difference of self-other intertemporal choice is greater than that in the pre-COVID-19 condition (interaction between A and C).						Hypotheses 3 is supported.
H4	The main effect of the domain is significant. Compared to the intertemporal choice in the economy domain, individuals prefer delayed options in the health domain (main effect of B).						Hypotheses 4 is supported.
H5	The interaction of COVID-19 status and domain is significant (interaction between A and B).						Hypotheses 5 is supported.
H6	The interaction of decision maker role and domain is significant (interaction between B and C).						Hypotheses 6 is not supported.
H7	The interaction among COVID-19 status, decision maker role, and domain is significant (interaction among A, B and C).						Hypotheses 7 is not supported.
H8	Psychological safety plays a moderating role on the relationship between COVID-19 and intertemporal choice (moderate the relationship between A and intertemporal choice).						Hypotheses 8 is supported.

Table 2
Items of safety questionnaire

Item	Agree completely	Kind of agree	Neutral	Kind of Disagree	Disagree completely
I never dare to volunteer my opinion.	1	2	3	4	5
I feel that life is always full of uncertainty and unpredictability.	1	2	3	4	5
I'm used to giving up my wishes and demands.	1	2	3	4	5
I'm always worried about what's gonna happen.	1	2	3	4	5
I never dare refuse a friend's request.	1	2	3	4	5
When I meet unhappy things, I always sulk or cry alone.	1	2	3	4	5
When I meet unhappy things, I always sulk or cry alone.	1	2	3	4	5
People say I'm shy and withdrawn.	1	2	3	4	5
I always worry that a relationship that's too good will turn sour.	1	2	3	4	5
I usually stay away from leaders.	1	2	3	4	5
I often worry that I will lose control of my thoughts or emotions.	1	2	3	4	5
I always "never ask for anything.	1	2	3	4	5
I always worry that my life will be a mess.	1	2	3	4	5
I felt powerless to cope or deal with the sudden dangers in my life.	1	2	3	4	5
I am afraid to establish or maintain close relationships with others.	1	2	3	4	5
I feel useless no matter what anyone says, you know.	1	2	3	4	5

Table 3
Descriptive statistics of preference for intertemporal choice (M ± SD)

COVID-19 Status	Self × Health	Self × Economy	Others × Health	Others × Economy
Pre-COVID-19	0.222 ± 0.330	0.258 ± 0.292	0.142 ± 0.293	0.161 ± 0.164
During-COVID-19	0.171 ± 0.311	0.352 ± 0.307	0.222 ± 0.349	0.294 ± 0.284

Table 4
Effect of Psychological Safety on Intertemporal choice

Variables	Model 1	Model 2	Model 3
COVID-19 status	0.180**	0.226**	0.249***
Psychological safety		0.172*	0.217**
COVID-19 status × Psychological safety			−0.252***
R ²	0.028	0.051	0.108
F	6.899**	6.495**	9.343***

Note: the data in the table are standardized regression coefficients. *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.

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